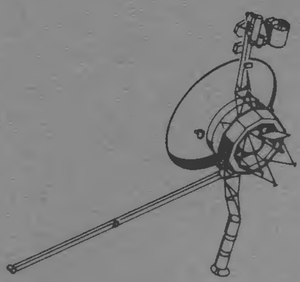

MISSION STATUS BULLETIN

VOYAGER

January 5, 1978 **No. 13**

SUMMARY

Voyager 1 now rightfully owns its title, having taken over the lead from Voyager 2 about December 15. Voyager 1 is now farther from both Sun and Earth than Voyager 2, and will continue to increase its lead until it is four months ahead at Jupiter encounter in early 1979.

Both spacecraft are now more than 1 AU from Earth, and almost 2 AU from the Sun [an AU (astronomical unit) is the mean distance from the Earth to the Sun, about 150,000,000 kilometers (93,000,000 miles)].

Voyager 1 is about 177 million kilometers (110 million miles) from Earth, travelling with a velocity* of about 27 kilometers (16.7 miles) per second, relative to the Sun. One-way communications with the spacecraft now take 9 minutes 49 seconds.

Voyager 2 is about 174 million kilometers (108 million miles) from Earth, travelling with a velocity* of about 26 kilometers (16 miles) per second, relative to the Sun. One-way communications time is now 9 minutes 40 seconds.

*Beginning with this bulletin, the velocities given will be heliocentric, that is, with respect to the Sun. Previously-stated velocities have been geocentric, or, relative to the Earth. More meaningful comparisons can be made when using the relatively stationary Sun as a reference point rather than the ever-moving Earth.

The Night Sky –

Amateur astronomers may be interested in observing two of Voyager's goals – Jupiter and Saturn – now easily visible to the unaided eye in the night sky. Four more of Voyager's targets – the Jovian satellites Io, Europa, Ganymede, and Callisto – may be observed with the aid of a small telescope.

At the western edge of the constellation Gemini, Jupiter is presently the brightest object in the evening sky and is visible from sunset to sunrise as it moves across the sky from east to west. It is near Orion's Belt, an easily-identifiable row of three stars. On January 21, the giant planet will be visible about five degrees north of the full moon.

Saturn rises in the eastern sky in early evening and remains there until sunrise. Located in the constellation Leo, it is brighter than a nearby star, Regulus. On January 20, Saturn will be visible about one degree north of Regulus.

MISSION HIGHLIGHTS

Celestial Object Observed

An unusual object was detected during standard camera calibrations on December 24. The object appeared to be approximately 30 meters (98 feet) in length and was made up of nine distinct images in linear sequence trailed by a larger, rectangular unit. Spectral analysis of this object revealed traces of red velvet and mammalian cilia. Additionally, the object proved to be a strong radio source. Prompt evaluation of emitted frequencies revealed the following message: "Ho, Ho, Ho . . . and a Merry Christmas to ALL!"

And a Happy New Year, too!

Sequence Verification Tests

Cruise provides an opportunity for "getting acquainted" with the spacecraft, learning exactly how it will perform and react. As part of this "getting to know you" strategy, sequence verification tests were performed on both spacecraft during December.

The purpose of the tests is to serve as a proof of the computer programs now being written for the planetary encounter activities. They are a rehearsal for the busy times to come.

The sequences verify expected spacecraft performance in tests that cannot be performed on Earth prior to launch. Since the space environment cannot be totally duplicated in Earth laboratories, various assumptions were made during design and fabrication of the spacecraft, based on models of spacecraft performance. During cruise, these models will be verified and refined.

December's sequence verification tests concentrated primarily on three areas of interest: microphonics, boresighting, and imaging rates.

Microphonics. Several of the instruments aboard Voyager are especially sensitive to the motion and noise created by other activities aboard the spacecraft, such as scan platform slewing or the stepper motors on several instruments. The microphonics tests measure the sensitive instruments' reactions of these interferences so that the effects can be minimized or, in later data analysis, obvious reactions to spacecraft noise can be disregarded.

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The plasma instrument and infrared interferometer spectrometer are the most sensitive to motion and noise generated on the spacecraft by various actuations. The motion of the scan platform, as well as the motors which rotate wheels on the photopolarimeter, imaging, and low-energy charged particle instruments, create the most noise.

The effect of these combined motions and noises cannot be satisfactorily studied on Earth, as no vacuum chamber has yet totally simulated the vacuum environment of space. Even the low levels of noise in the test area affect the tests. In addition, the scan platform is difficult to maneuver on Earth due to the mass of the instruments, nearly 91 kilograms (200 pounds), perched on its tip.

Boresighting. All of the instruments aboard Voyager are interactive to some degree; that is, their data are supplementary and complementary. In particular, the ultraviolet spectrometer, photopolarimeter, and imaging cameras, all mounted on the scan platform, must be aligned to look at the same position at the same time. The boresight tests consist of slewing the scan platform across the sky to determine if the three instruments observe the same star at the same time and are therefore well-aligned. The tests verify that the alignment is the same as pre-launch.

Imaging Rate. Several instruments, including the imaging cameras, planetary radio astronomy subsystem, and plasma wave subsystem, must return data at the highest rate possible, 115 kilobits per second. Verification of proper performance at this rate is needed prior to encounter.

UPDATE

VOYAGER 1

During the sequence verification tests on December 14/15, the filter wheels of the imaging cameras aboard Voyager 1 were observed not to be stepping. The cameras were turned off and the heaters were turned on. Both the narrow- and wide-angle cameras were in the clear filter position when the cameras were turned off (both cameras also have seven other filters).

The source of the problem has not been isolated. A sequence of diagnostic tests has been developed and will be conducted in mid-January. It is expected that tests will prove that a redundant element can be implemented.

On December 13, Voyager 1 conducted a fairly extensive mapping of the Orion nebula. Both the ultraviolet spectrometer (UVS) and photopolarimeter (PPS) continue to observe a limited number of stellar targets. These observations are proving to be invaluable astronomical tools, providing precise pointing over an extended period of time, gathering original data on emissions in the ultraviolet and visible light ranges, and making fundamental science observations and calibrations.

VOYAGER 2

Voyager 2 completed the sequence verification tests December 5, 7, and 8 without incident.

On December 27/28, Voyager 2 performed a cruise science maneuver. The maneuver consists of rolling the spacecraft in one direction for about 5 hours and then rolling it about the roll axis for about 12 hours. The last roll turn was finished 20 seconds earlier than the computer expected, and a "safing" sequence was executed, one of the built-in safety features of the spacecraft. The turn tolerance will be adjusted to accommodate the spacecraft performance on future cruise science maneuvers.

The cruise science maneuver allows calibration of several instruments by turning the spacecraft to look at the entire sky. The scan platform instruments are able to map the sky as the spacecraft rolls, and the ultraviolet spectrometer and photopolarimeter make their observations against the total sky background. The magnetometers and plasma instrument also obtain calibration data.

A significant decrease in sensitivity has been noted on Voyager 2's infrared interferometer spectrometer (IRIS). The condition will be monitored over the next few months to detect stabilization or any further change. A deep space observation calibration is scheduled for February 8.

A degradation of the S-band radio solid-state amplifier in the high power mode has been noted. The amplifier has been switched to the low power mode and is being monitored. The radio system has built-in redundancy, using both the solid-state amplifier and a travelling wave tube amplifier.

THE VOYAGER SPACECRAFT

RADIOISOTOPE THERMOELECTRIC GENERATORS

(This is the third in a planned series of brief explanatory notes on the spacecraft and its subsystems).

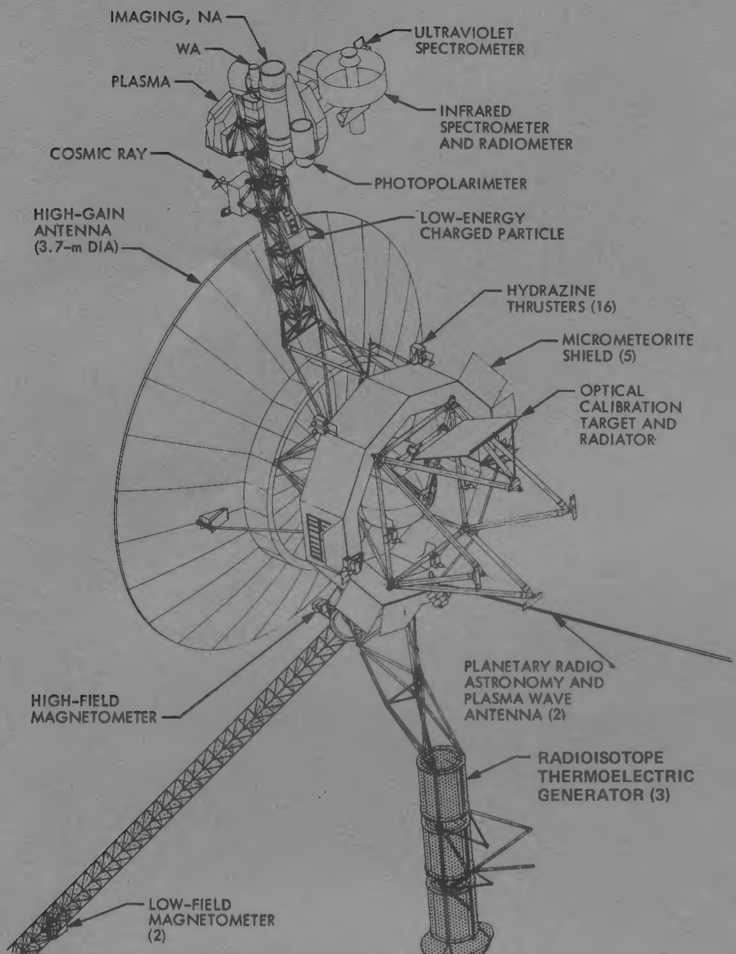
Far away from electrical outlets, and with no solar panels, Voyager needs power to operate its various motors, heaters, and other mechanical parts. Nuclear power provides the solution.

Each spacecraft carries three radioisotope thermoelectric generators (RTGs) mounted in tandem (end-to-end) on a boom which was deployed shortly after the spacecraft entered Earth orbit about one hour after launch. The generators are located on the boom 180° from the scan platform boom to minimize the effects the radiation they generate may have on the science instruments. The distance between the nearest RTG and the nearest science instrument on the scan platform boom is about 16 feet.

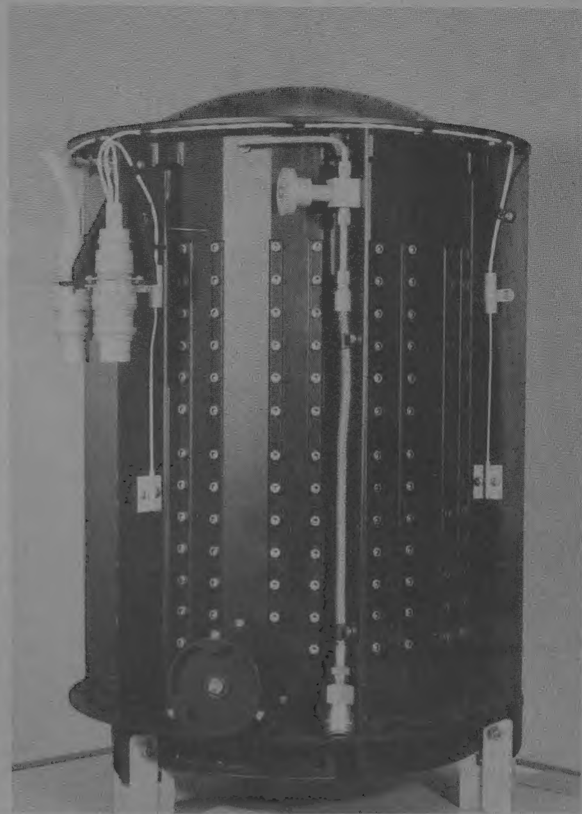
The RTG units convert to electricity the heat released by the decay of Plutonium-238, a radioactive isotope. The minimum total power available from the three RTGs ranges from about 423 watts within a few hours after launch to 384 watts after the spacecraft passes Saturn. The science instruments require about 105 watts of this total – slightly more than an ordinary household light bulb. The remaining power is used by other spacecraft subsystems.

The RTGs are activated about 1 minute after liftoff when an inert gas in the generator interiors is expelled via a pressure relief device. The inert gas serves to prevent oxidation of the hot components of the units. After activation, the RTGs do not reach full power until about six to eight hours after launch, when the spacecraft is well beyond Earth.

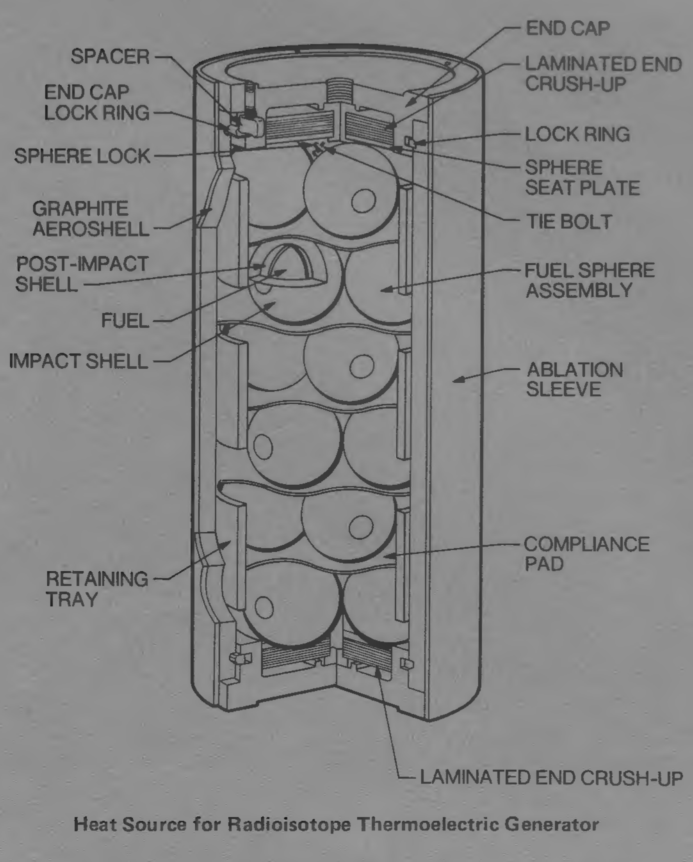
Power from the RTGs is held at a constant 30 volts direct current (Vdc) by a shunt regulator. The 30 volts is supplied directly to some spacecraft users and is switched to others in the power distribution assembly. The main power inverter converts the 30 volts direct current to 2.4 kiloHertz square wave (ac) for use by most spacecraft subsystems.



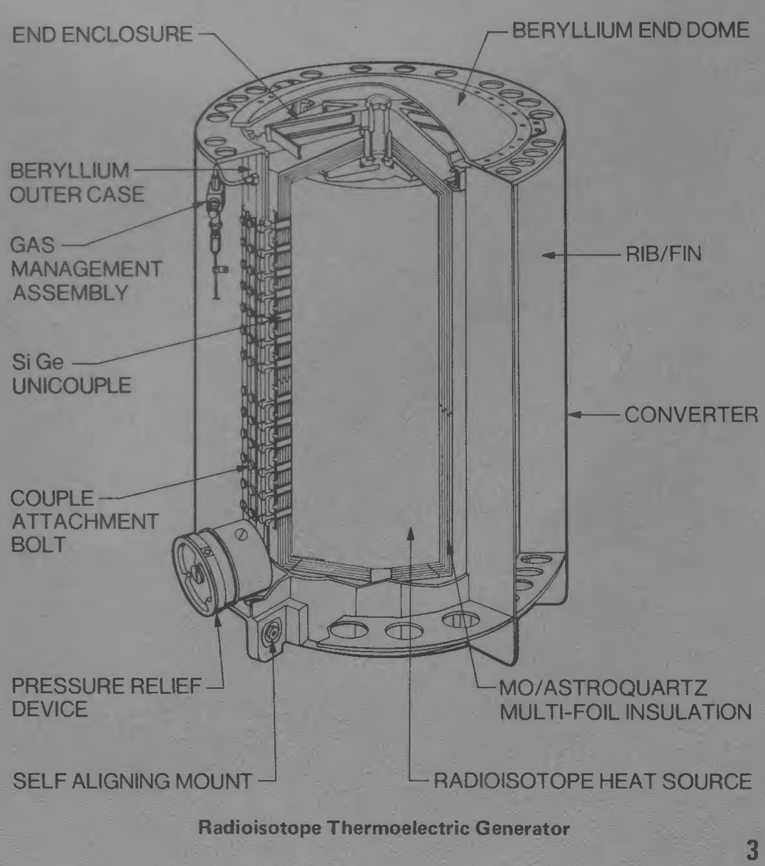
(SPACECRAFT SHOWN WITHOUT THERMAL BLANKETS FOR CLARITY)



Model of Radioisotope Thermoelectric Generator Unit



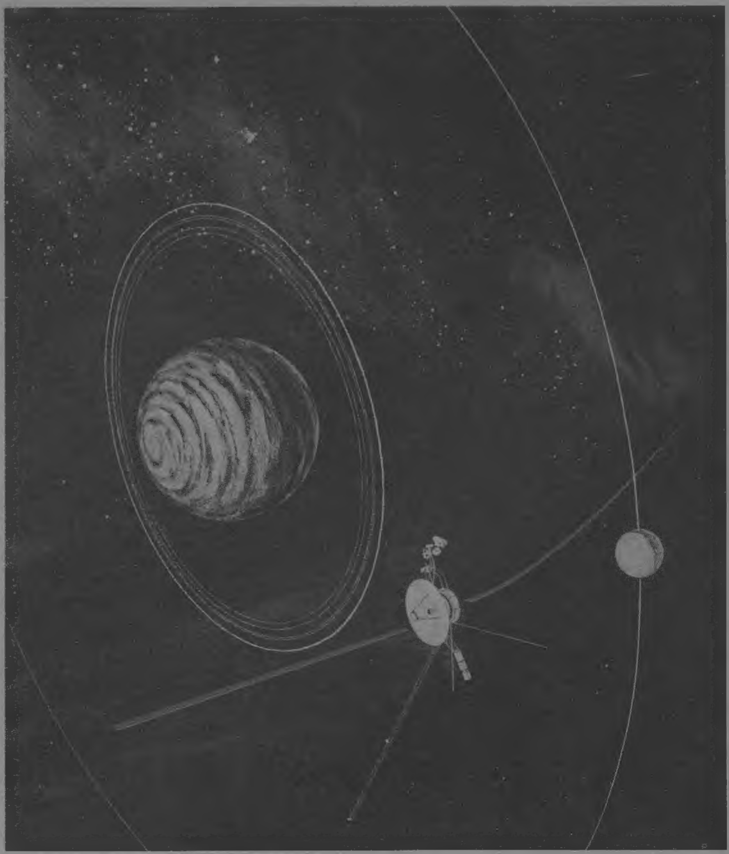
Heat Source for Radioisotope Thermoelectric Generator



Radioisotope Thermoelectric Generator

A CLOSE LOOK AT JUPITER — Voyager spacecraft aims its instrument scan platform at the planet Jupiter in this painting depicting a major step in the mission. Voyager 1 will fly past Jupiter March 5, 1979, and then will continue on to ringed Saturn. Voyager 2 will arrive at Jupiter July 9, 1979, and will follow its predecessor to Saturn.

PASSING SATURN — The Voyagers will arrive at Jupiter in March and July 1979, and at Saturn in November 1980 and August in 1981. Each craft carries ten scientific instruments to measure interplanetary space, the planets, and their satellites (including photography). An eleventh experiment uses Earth and spacecraft radios to measure planet and satellite atmospheres.



ON TO URANUS — This painting depicts Voyager 2 observing Uranus in January 1986. The option to target for Uranus exists only for Voyager 2. Uranus is tilted on its axis so its poles point towards the Sun. Its rings were discovered in 1977.